Multidetector CT findings suggesting a perforation site in the gastrointestinal tract: analysis in surgically confirmed 155 patients

Masanori Imuta · Kazuo Awai · Yoshiharu Nakayama
Yuka Murata · Chiaki Asao · Tetsuya Matsukawa
Yasuyuki Yamashita

Abstract

Purpose. The aim of this study was to investigate how accurately we could diagnose the level of gastrointestinal (GI) tract perforation using multidetector computed tomography (MDCT).

Materials and methods. We reviewed 155 patients with surgically confirmed GI tract perforation. MDCT scans were obtained with eight-detector CT; 5 mm thick axial images and 2.5 mm thick coronal multiplanar reconstruction (MPR) images were generated for all patients. Contrast enhancement was performed in 44 of the 155 patients. Two board-certified radiologists reviewed the images for direct findings (free air, ruptured GI tract wall) and indirect findings (inflammatory changes, fluid collection, focal thickening of the GI tract wall) and attempted to identify the perforation site in each patient.

Results. Free air was seen in more than 95% of the patients with perforation at sites other than the appendix; free air was seen in 44% of patients with appendicitis. On contrast-enhanced CT performed in 44 patients, rupture of the wall of the GI tract was directly visualized in 14 (32%) on axial images only and in 23 (52%) on axial or MPR images, respectively. The perforation site was correctly diagnosed in 90% of the patients when the radiologists referred to both direct and indirect findings.

Conclusion. MDCT was valuable for identifying the presence and level of GI tract perforation.

Key words MDCT · Perforation · Gastrointestinal tract · MPR

Introduction

Gastrointestinal (GI) tract perforation, an emergency that requires prompt surgery, may be attributed to a variety of causes. Usually, the diagnosis of GI tract perforation is based on imaging findings. Correct identification of the presence, level, and cause of the perforation is essential for appropriate management and surgical planning. Plain radiography remains the first imaging study; however, the clinical and radiographic diagnosis of GI tract perforation is often difficult. Symptoms can be nonspecific, and extraluminal air is identified radiographically in only 50%–70% of cases.1,4

Computed tomography (CT) is highly effective in this field,5,9 and the utility of CT in GI tract perforations due to peptic ulcer disease, diverticulitis, trauma, appendicitis, or Crohn’s disease has been well documented.5,7,10–19 Amounts of extraluminal air too small for detection by conventional radiography can be demonstrated by CT. Indirect findings of bowel perforation—phlegmon, abscess, peritoneal fluid, the presence of an extraluminal foreign body—on CT can be also diagnostic clues pointing toward perforation.7,9,20

Multidetector CT (MDCT), which has recently come into widespread use, makes it possible to examine the entire abdomen in thin sections during a single breathhold. To the best of our knowledge, there have been only a few reports about GI tract perforation evaluated by
MDCT. We undertook this study to assess retrospectively the value of MDCT in the diagnosis of GI tract perforation. The purpose of our study was to investigate how accurately we could diagnose the level of GI tract perforation using MDCT.

**Materials and methods**

**Patient population**

One abdominal radiologist (M.I.) with 8 years of abdominal CT experience reviewed the records of patients who had undergone abdominal CT during a 36-month period from November 2002 to November 2005. Among them, he identified 155 patients with a surgical diagnosis of GI tract perforation; patients with esophageal wall perforation were excluded from this study because we focused on abdominal CT. Our institutional review board approved the use of the CT database; and informed specific study-related patient consent was waived.

The interval from CT to surgery ranged from 2 h to 7 days (mean approximately 2 days). There were 89 men and 66 women ranging in age from 17 to 95 years (mean 68.5 years). The perforation was due to peptic ulcer in 48 patients, appendicitis in 32, diverticulitis in 29, GI tract carcinoma in 28, foreign body in 7, Crohn’s disease in 7, iatrogenic causes in 3, and trauma in 1. In all patients, the location of the perforation was confirmed by surgery.

**CT imaging**

The CT examinations were performed with an eight-detector CT scanner (LightSpeed Qx/i-Plus; GE Medical Systems, Milwaukee, WI, USA); the parameters were the following: rotation time 0.6 s; detector collimation 8.0 × 2.5 mm; helical pitch 1.375; gantry rotation time 0.5 s; reconstructed section thickness 2.5 and 5.0 mm; reconstructed section interval 2.5 and 5.0 mm; tube voltage 120 kV; tube current–time product 200 mA. Image reconstruction was in a 25- to 35-cm display field-of-view depending on the patient’s physique. All scans were started at the top of the liver and moved to the base of the pelvic cavity in a cephalocaudal direction. The patients were instructed to hold their breath with tidal inspiration during scanning.

Of the 155 patients, 111 received neither oral nor intravenous (IV) contrast administration. In the other 44 patients, 100 ml of iohexol with an iodine concentration of 300 mg/ml (Omnipaque 300; Daiichi Pharmaceutical, Tokyo, Japan) was injected IV at a rate of 1.5–2.0 ml/s with a power injector. Scanning was started 90 s after the start of the contrast injection; this scan timing corresponds with the portal venous phase.

We generated 2.5 mm thick coronal multiplanar reconstruction (MPR) images for all 155 patients from axial source images with a section thickness of 2.5 mm.

**Image interpretation**

Two board-certified radiologists with 8 and 15 years of experience, respectively, independently reviewed the CT images. They read body and abdominal CT images on a regular basis. In cases where their initial assessment differed, they reevaluated the CT images until they reached consensus. The readers were blinded to all patient records; they were not cognizant of the patients’ clinical background or their surgical and pathological diagnosis. They were told that the patients had presented at the emergency department complaining of acute abdominal pain and that GI tract perforation was suspected.

We classified the CT findings of GI tract perforation as direct and indirect signs. Direct findings included extraluminal air (free air) and direct visualization of GI tract wall rupture. We evaluated direct visualization of GI tract wall rupture in the 44 patients who had undergone contrast-enhanced CT and the 99 patients who had undergone nonenhanced CT imaging. Indirect findings included inflammatory changes or a fluid collection in the surrounding soft tissues or organs and focal GI tract wall thickening.

We first assessed the perforation sites with a direct sign if there was one; then we assessed those with direct and indirect signs. We classified the intraperitoneal space into the region around the liver, around the stomach, in the mesentery, in the pelvis, and in the retroperitoneal space; we recorded the presence and location of direct and indirect signs in each patient.

In general, the transverse mesocolon divided the intraperitoneal space into the supramesocolonic and inframesocolonic regions. On CT, the transverse mesocolon is identified as the fatty plane extending from the pancreas, particularly at the level of the uncinate process, to the ventrally situated transverse colon with middle colic vessels coursing through it. Thus, we also recorded whether free air was located in the supramesocolonic or inframesocolonic region.

**Results**

Among the 155 patients, the perforation site was in the stomach in 38, the duodenum in 46, the small bowel in